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(71) Applicant (for all designated States except US): IDENTIC AB [SE/SE]; Box 143, S-186 23 Vallentuna (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): KÄLLBERG, Sylvid [SE/SE]; Värmlandsvägen 16, S-186 35 Vallentuna (SE).

(74) Agents: ALBIHNS STOCKHOLM AB et al.; Box 5581, S-114 85 Stockholm (SE).

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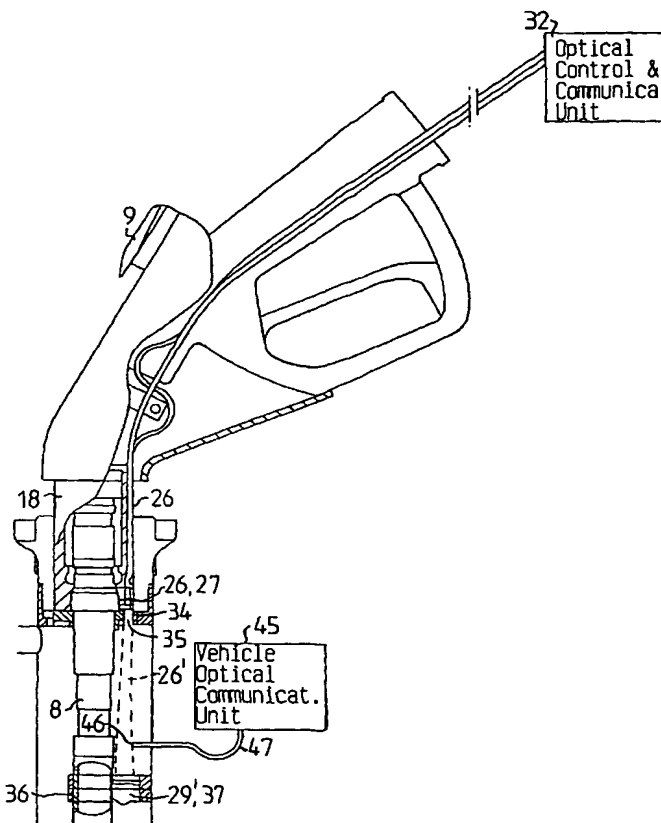
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(54) Title: METHOD AND SYSTEM FOR REFUELLING



(57) Abstract: Method for spill free refuelling comprising establishing a liquid tight connection between a refuelling gun nozzle for fuel dispensing and a coupling piece of the fuel receiving object (6), through which fuel is provided to a fuel container (7), detecting a predetermined fuel level (8') and automatically interrupting the fuel flow when said level is detected. The method is especially characterized in that a level detection signalling configuration is established by moving the gun into position for establishment of the liquid-tight connection. The invention further relates to a system for spill free refuelling, a method and a device for detecting a predetermined liquid fuel level and a fuel pipe arrangement.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND SYSTEM FOR REFUELLING

BACKGROUND OF THE INVENTION

5 1. Field of the invention

The present invention generally relates to the technical field of refuelling.

10 The present invention relates to a method and a system for refuelling, and a method and a device for detecting a limit fuel level and to a fuel pipe for a fuel container.

More specifically the invention relates to the technical field of spill free refuelling.

15 The present invention is especially suitable for the refuelling of vehicles. In such cases the fuel is sometimes inflammable and the fuel vapour is explosive. In addition to this, some fuels, like methanol, have toxic properties and the use in fuel cells is sensitive to contamination. Many vehicles are refuelled by non-professionals, i.e. persons that need an extremely safe and simple refuelling procedure and equipment. The following description of prior art, problems associated with such art and the
20 purpose and features of the invention, will therefore, as non-limiting examples, to a certain extent be directed to this field of use. However, it should be pointed out that the invention may be used for other liquids and other refuelling objects, such as diesel oil for houses etc.

25 Refuelling is nowadays and will most probably also in the future be performed by non-professional operators, e.g. drivers of cars. There has also been a development towards other kinds of fuels, e.g. methanol for fuel cell use. This development calls for very secure, simple and easy-to-handle refuelling systems, considering e.g. toxic properties of such fuels. Also, extremely strict rules for use and handling of such fu-
30 els may be expected, if not already present.

2. Prior art

Spill-free refuelling techniques are previously known. Thus, it is known to arrange a liquid-tight connection between a fuel dispensing nozzle and a fuel receiving coupling piece or nipple and to arrange an electric/electronic fuel level sensor arrangement in the fuel container. To activate the sensor arrangement, the arrangement has to be connected to a central control unit by means of a cable before refuelling. This means a quite complex procedure and several actions for the operator to remember, which leads to safety problems. Furthermore, the use of electric/electronic sensor arrangements requires quite complex and expensive arrangements to obtain a system, which is safe from a spark/fire point of view, when it comes to certain fuels, e.g. methanol.

SUMMARY OF THE INVENTION

One object of the invention is to provide a method and a system for spill free refuelling, which are extremely simple and safe to operate.

This object is achieved by a method according to the attached claim 1 and a system according to the attached claim (19), a method according to claim (41), a device according to claim (48) and a fuel pipe arrangement according to claim (58).

According to a first aspect, the invention relates to a method according to the introductory part of claim 1, the method being especially characterized by what is specified in the characterizing portion of said claim. According to this aspect, the invention also relates to a system according to the introductory part of claim (19) the system being in particular characterized by what is specified in the characterizing clause of claim (19).

One advantage of the invention according to this aspect is that a predetermined fuel level detection configuration is established by applying the fuel dispensing gun in refuelling position, this being very simple and safe, even with a non-professional operator.

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According to a second aspect, the invention relates to a method according to the introductory part of claim (41), the method being especially characterized by the features of the characterizing clause of said claim. According to the same aspect, the invention also relates to a device according to the introductory portion of claim (48),
10 the device being characterized in particular by what is specified in the characterizing clause of claim (48).

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One advantage of the invention according to this aspect of the invention is that the operation procedure is optical and, thus, non-electric/non-electronic, which is most important from a safety point of view.

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According to a third aspect, the present invention relates to a fuel pipe arrangement according to the introductory portion of claim (58), the arrangement being especially characterized by what is stated in the characterizing clause of the last mentioned claim.

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One advantage of the invention according to this aspect is that it provides a support for level detection means in the container and provides possibilities for safe detection access to the container.

These and further aspects and advantages of the present invention will be apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention will be had upon the reference to the following detailed description when read in conjunction with the accompanying drawings, wherein like reference characters refer to like parts throughout the several views, and in which:

Fig. 1a is a side view of a refuelling handle according to the invention, shown partly in cross section and prior to being connected to a fuel pipe arrangement;

Fig. 1b is a side view of a fuel pipe arrangement according to the invention, shown partly in cross section and before being connected to the handle of Fig. 1a;

Fig. 2a is a side view of the handle and pipe of Figs. 1a and b during an initial connection stage, the handle being shown in further cross section;

Fig. 2b is a detailed view of Fig. 2a, showing a nozzle of the handle and a coupling piece or nipple of the pipe;

Fig. 3a is a side view of the arrangement according to Fig. 2a in a final connection stage;

Fig. 3b is a side view of the arrangement according to Fig. 2b in the final connection stage;

Fig. 4a is a side view of the arrangement according to Fig. 3a in a connected stage, an arrangement for optical fuel level detection according to the invention also being shown;

Fig. 4b is a detailed cross section of a light transfer arrangement of fig. 4a;

Fig. 5 is a cross section A-A of Fig. 6;

Fig. 6 is a view from the right in Fig. 4a of the light transfer arrangement in cross section;

Fig. 7 is a top view of a nipple bracket, shown in cross section in Fig. 4a and comprising an arc shaped light passage slit;

Fig. 8 is a view of a prism and lens arrangement of a level detection means according to the invention, the views from top to bottom being a bottom view, a side view and a top view;

Fig. 9 is a top view of a prism and lens holder intended to be attached to the fuel pipe according to Fig. 4a;

Fig. 10 is an illustration of an angle interval allowed for the handle in relation to the fuel pipe due to the slit and prism and lens arrangement for maintained light detection;

Fig. 11 is a view from the right in Fig. 4a and an illustration of the light transfer, reflection and detection during refuelling before a predetermined fuel level is obtained;

Fig. 12 is an illustration corresponding to Fig. 11 when said level is obtained;

Fig. 13-15 is an illustration of disconnection of the handle pipe arrangement according to Fig. 1a and b in three stages,

Fig. 16 is a schematic representation of two spots of reflected light deviated from the light transferred to the prism and lens arrangement and to be detected; and

Fig. 17 is a schematic representation of a refuelling system according to the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

With reference first to Figs. 1-3 the system according to the invention comprises a refuelling handle or gun 1, having a trigger 2 for starting and stopping flow through the gun and being connected to a flexible pipe 3, indicated by dashed lines, connecting the gun with a pump or the like, not shown, for fuel provision. The gun carries a nozzle 4 arranged to be part of a liquid tight, so called spill free, connection, the other part being a coupling piece 5 or nipple 5 carried by the object 6 to be refuelled, not shown specifically, through which coupling piece fuel is intended to be provided to a fuel container 7 of said object, said coupling piece being fixed to the upper part of a fuel pipe 8 arranged in the fuel container.

A preferred embodiment of the coupling and connection arrangement is shown in Figs. 1-3, said arrangement comprising an indication and release means in the form of a knob 9 arranged to be seen and reached by an operator of the gun and preferably being arranged in an opening 10 in the gun cover 11 near the trigger so that it is operable by a one-hand grip around the gun handle and trigger part 12 of the gun. According to the embodiment shown the knob is carried by one end part 13 of a linkage arm 14, the linkage arm being arranged to be turned around a centrally positioned joint 15 between a release position, Fig. 2a, and a coupling position, Fig. 3a, and to, by its other end part 16, co-act with a release ring 17, which is tiltably connected to an outer sleeve 18 of the nozzle at the part 19 of the sleeve, which is turned to the knob, said outer sleeve being arranged to be moved towards the coupling piece in relation to the release ring and an inner nozzle part 20 during the nozzle and coupling piece connection procedure, as can be seen in detail in Figs. 2b and 3b, whereby the release ring is tilted and levelled out against a connection sleeve 21 of said inner nozzle part and whereby the release ring turns the linkage arm and the knob from said release position to said coupling position, as indicated by an arrow 9' in Fig. 3a.

The release ring has an extension 22 arranged to co-act with the linkage arm end and is preferably connected to the outer sleeve by means of two Allen key bolts 23 attached to the release ring with their heads 24 acting as glide bearings in corresponding holes, not shown, in the outer sleeve. In order to securely hold the nozzle in place, locking balls 25 at the inner surface of the outer sleeve are provided and arranged to be forced by the outer sleeve into a groove 25' in the coupling piece, as can be seen in Figs. 2b and 3b.

The connection is arranged to be released as can be seen in Figs. 13-15, an operator pushing the knob and linkage arm from the coupling position to the release position and thereby tilting the release ring, which, due to its attachment to the outer sleeve is

arranged to push the connection sleeve 21 towards the nozzle free end and thereby releasing the coupling piece from the nozzle, as shown in the Figures.

5 The fuel connection for transferring fuel from the nozzle to the coupling piece or nipple of the fuel-receiving object is, in order to obtain a spill free connection, preferably of the type where the nozzle and the coupling piece are arranged so that the fuel connection is opened in successive steps during the coupling procedure, the nozzle being arranged to open the coupling piece and the coupling piece being arranged to open the nozzle thereafter and vice versa when closing, the nozzle being
10 closed before the coupling piece being closed.

The system according to the invention further comprises means for detecting a predetermined fuel level in the fuel container and for automatically interrupt the fuel flow when said level is detected. The system is arranged so that a level detection
15 configuration is established by means of moving the gun 1 into position for establishment of the liquid tight connection. A preferred embodiment is shown in Figs. 4-12.

Carried and supported by the gun is an optical fibre 26 and lens 27 arrangement arranged for transferring a beam of optical detection signals 26' to the container and
20 an optical fibre 28 and lens 29 arrangement for receiving optical detection signals, reflection means 29' being arranged in the fuel container to receive optical signals, preferably in the form of visible light, transferred to the container, the reflection means being arranged to reflect the optical signals when the fuel level has not yet
25 reached the reflection means and to transmit a considerable part of the optical signals when the fuel has reached the reflection means due to a change in refractory configuration, the change in reflected signal being intended to be taken as an indication for the fuel to have reached the predetermined level, as shown in Figs. 11 and 12.

According to the embodiment shown, the optical fibre 26 and the lens 27, constituting a light source, for transferring optical signals are held together by a lens holder 31 arranged in a groove in the outer surface of the outer sleeve, signals being provided from a control and communication central unit 32, and the optical fibre 28 and lens 29 arrangement, constituting a light sensor for receiving reflected signals, are held together by a lens holder 33 arranged in a groove in the outer surface of the outer sleeve relatively close to the transfer arrangement 26, 27, preferably about 6 mm: therefrom, both arrangements being positioned at the end of the outer sleeve. The lenses 27, 29 are arranged to concentrate the light.

Said nipple or coupling piece is held by a nipple bracket 34, against which the outer sleeve is intended to be applied, the nipple bracket comprising a, preferably arc-shaped, slit 35 through which optical signals are intended to pass from and to said arrangements 26, 27 and 28, 29 respectively.

The reflection means are arranged in a holder 36 attached to the internal fuel pipe below the slit, the slit and the reflection means being fixed in relation to each other.

The reflection means are arranged so that a certain deviation between transferred optical signals and reflected optical signals is provided, so that the transfer and sensor arrangements may be positioned close together, as discussed below.

The reflection means comprises a prism and lens arrangement 37, preferably having an arc-shaped configuration having the same or approximately the same reflection properties irrespective of where along the arrangement optical signals are coming in, whereby the gun may be applied and turned within a certain angle interval 38, Fig. 10, substantially maintaining the effective reflection properties.

According to the preferred embodiment the reflection means comprises at least one so-called cube corner prism 39 of the kind that is arranged to reflect in coming light

back in substantially the opposite direction and having the configuration of a cut-off cube corner, the surface 40 of cut corresponding to a light receiving surface 40, against which light to be reflected is intended fall in.

- 5 The embodiment shown, specifically shown in Fig. 8, comprises three cube corners 39 in an arc-shaped row in order to obtain an elongated reflection means, preferably adapted to the shape of the slit 35.

As described above the predetermined level is intended to be detected as a change in
10 the reflected optical signal from high to low signal level corresponding to transmission instead of reflection. In order to keep this signal change far above stray light level in the environment of the reflection means, complementary optics 41 for the cube corner prisms are preferably provided, intended to increase the high (reflection configuration) signal level, said optics being arranged on the top surface 40 of each
15 cube corner prism. According to one embodiment the complementary optics for each cube corner prism comprises a spherical lens part 42 and a cylindrical lens part 43. Each part 42, 43 constitutes a portion of a lens, the central portions 42', 43' of the two parts abutting each other and the optical axes 42'', 43'' of the two parts being off-set with respect to each other and with respect to the centre 39' of the cube corner prism, the optical signal coming in against one half being intended to be re-
20 flected and through the abutting half and the line of cut 39'' between the two half lenses being directed towards the rotation centre 39''' of the mechanical system and passes the centre axes 39' of the cube corner prism. Each of the two halves for each cube corner prism is arranged to deviate transferred and reflected optical signals re-
25 spectively in the same direction and to concentrate the reflected signals to two spots S, S', Fig. 16, a short distanced, preferably about 6 mm:s, beside the optical signal transfer arrangement 26, 27, one on each side, one of the spots thus being intended to fall on the optical signal receiving arrangement or sensor 28, 29. This provides for possibilities to choose the cut off level between high and low in such a way that
30 it is not so noise sensitive.

The complementary optics 41 described above is a solution based upon standard lenses, the basic aim, however, being to compensate for poor tolerances with respect to the positioning of the transfer arrangement 26, 27 carried by the handle. The cylindrical lens is "off-spherical" for such compensation. One alternative is to design both lens halves to have an "off-spherical" shape.

According to the preferred embodiment means for detecting complete and secure connection between the nozzle and the coupling piece by means of the level detection signalling configuration are provided, said configuration being fully established when said connection is completed. According to one embodiment shutter means 44, Fig. 3a, of the linkage arm arrangement for said knob is provided, by means of which reflected optical signals are stopped from being communicated to further processing when said knob and linkage arm is in the release position, said communication being opened by moving said shutter means when the knob is moved to the coupling position.

In order to provide for communication with the fuel receiving object 6 a two-way optical communication between an optical communication unit 45 of said object carried by the object is arranged for communication with the optical control and communication central unit. According to a preferred embodiment, the two-way optical communication is arranged by means of light decoding and a communication prism 46 with a dual optical communication fibre 47 connected to the object optical communication unit 45.

In Fig. 17, a schematic illustration of a system for performing the invention is shown. The system comprises a central control and communication unit 48 including the optical control and communication unit 32. The central unit is preferably connected to an ID-unit 49 by means of which an operator may identify himself by means of a card, code etc. before refuelling for billing purposes etc. in order to "log

in" and obtain access to the refuelling system. Connected to the central unit is, as earlier described, an object optical communication unit for transfer and reception of information to and from, respectively, the central unit, this information being e.g. the correct fuel type, object ID etc. for control etc.

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Thus, the central unit is arranged to receive information from the detection means 26, 27, 28, 29, 29' as to when said predetermined limit fuel level 8' is obtained, and is connected to valve means 50, e.g. a magnetically operated valve of the pump and dispensing arrangement 51 of the system, said valve being arranged to receive close and open orders from the central unit and, more specifically a close order when the limit level is obtained and open order after re-setting of the system corresponding to a new refuelling cycle or continuation of an interrupted refuelling, the system having a delay function, interrupting refuelling access when refuelling activity has not occurred for a predetermined time period, etc.

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The methods as well as the function of the systems, devices and arrangements according to the invention should to a considerable extent have been made clear from the description given above.

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Thus, after having been logged into the refuelling system, an operator applies the dispensing nozzle onto the coupling piece and establishes connection for fuel transfer, indication of success being made by the knob 9. At the same time the optical limit level detection configuration is established if the gun is within the approved angle interval 38 and the central unit receives reflected signal information. The

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valve means are given order to open and refuelling can start by trigger 2 action. When the predetermined level is reached or when the operator pushes the knob to the release position or a predetermined interruption has occurred, the corresponding signals are detected by the central unit, which gives close order to the valve means. Release of the connection is then performed as described earlier.

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The invention has been described above in association with preferred embodiments. Of course further embodiments and minor amendments and complementary changes may be imagined without leaving the basic inventive idea.

5 Thus, for security reasons a breakpoint arrangement, not shown, is provided; preferably on the pipe 3 leading to the gun, to obtain a break if the operator eg drives off without releasing the connection, the breakpoint arrangement being resettable and comprising a valve arrangement for spill free break.

10 Further, the prism and lens parts of the reflection means are preferably made of one or more polymeric materials chosen to provide proper optical properties and to resist the fuels to be used, eg gasoline, methanol, ethanol or mixtures of such fuels.

The prism and lens arrangement of the reflection means may be designed differently
15 than according to the embodiments shown and described above, especially in view of the fact that the arrangement may be made from polymeric materials. Thus, an arrangement may be imagined, which comprises several rows of cube corner prisms, each with a lens arrangement. Other patterns, eg with straight rows and rows in
20 which the prisms are arranged at a certain distance from each other are also imaginable. Further, prism and lens arrangements made in one piece may be imagined, and said piece may be cut from a larger piece having the same prism and lens configuration.

Claims

1. Method for spill free refuelling comprising establishing a liquid tight connection between a refuelling gun nozzle for fuel dispensing and a coupling piece of the fuel receiving object, through which fuel is provided to a fuel container, detecting a pre-determined fuel level and automatically interrupting the fuel flow when said level is detected,

characterized in that a level detection signalling configuration is established by moving the gun (1) into position for establishment of the liquid-tight connection.

2. Method according to claim 1, **characterized in** that signals (26') for detecting said predetermined level are transferred to the fuel container (7) from means (26, 27) carried and supported by the gun.

3. Method according to claim 1 or 2, **characterized in** that a signal corresponding to detection of said predetermined level is transferred to receiving means (28, 29), carried and supported by the gun for further processing.

4. Method according to claim 1, 2 or 3, **characterized in** that said predetermined level is detected by means of optical signals.

5. Method according to claim 4, **characterized in** that optical signals (26') are transferred from an optical fibre (26) and lens (27) arrangement on the gun and optical signals are received by an optical fibre (28) and lens (29) arrangement on the gun.

6. Method according to claim 4 or 5, **characterized in** that optical signals, preferably in the form of visible light, are transferred to reflection means (29', 37) in the container, the reflection means being arranged to reflect the optical signals when the fuel level has not reached the reflection means and to transmit a considerable part of the optical signals when the fuel has reached the reflection means due to a change in refractory configuration, and in, that the change in reflected signal is taken as an indication for the fuel to have reached the predetermined level.

7. Method according to claim 6, **characterized in** obtaining a certain deviation between transferred optical signals and reflected optical signals by the reflection

means so that means for transfer (26, 27) and means for receiving (28, 29) can be positioned close together on the gun, a preferred distance (d) between said means being about 6 mm:s.

5 8. Method according to claim 6 or 7, **characterized in**, that reflection of transferred optical signals is obtained by a prism and lens arrangement (37) preferably having an arcshaped configuration and being designed so that approximately the same reflection properties are obtained irrespective of where along said arrangement (37) transferred optical signals are coming in, whereby the gun may be applied and turned within a certain angle interval (38) substantially maintaining the effective
10 reflection properties.

9. Method according to anyone of claims 6, 7 or 8, **characterized in** that, reflection is obtained by at least one cube corner prism (39).

10. Method according to claim 9, **characterized in** that reflection is obtained by at least three cube corner prisms arranged in a row.

15 11. Method according to anyone of claims 9 or 10, **characterized in** that each cube corner prism is provided with complementary optics (41) in the form of two lens parts (42, 43) for obtaining a deviation between transferred optical signals and reflected optical signals and for concentration of the reflected optical signals.

20 12. Method according to claim 8, 9, 10 or 11, **characterized in**, that optical signals are transferred through a slit (35) on the fuel receiving object side of the connection, the slit being fixed in relation to the reflection means, the slit setting said angle interval.

25 13. Method according to anyone of claims 1-12, **characterized in**, that complete and secure connection between the nozzle and the coupling piece is detected by means of the level detection signalling configuration, which is not fully established until said connection is completed.

14. Method according to anyone of claims 1-13, **characterized in**, that completed and acceptable connection between the nozzle and the coupling piece is indicated by a mechanical indication and release arrangement of the gun by moving a release

knob (9) from a release position to a coupling position, release of the connection being initiated by an operator pushing said knob back to the release position.

15. Method according to claim 14, **characterized in**, that reflected optical signals, are stopped from being communicated to further processing by shutter means (44) of a linkage arm (14) arrangement for the knob when said knob is in the release position, said communication being opened by moving said shutter means when the knob is moved to said coupling position.

16. Method according to anyone of the proceeding claims, **characterized in**, that the fuel connection between the nozzle and the coupling piece is opened in successive steps during the coupling procedure, so that the nozzle opens the coupling piece whereafter the coupling piece opens the nozzle, and vice versa when closing, so that the nozzle is closed first whereafter the coupling piece is closed.

17. Method according to anyone of claims 6-16, **characterized in**, carrying the reflection means by a fuel pipe (8), through which fuel is entered into the fuel container and which ends below said predetermined fuel level (8').

18. Method according to anyone of the preceeding claims, **characterized in**, a two-way optical communication between an object optical communication unit (45) and an optical control and communication unit (32).

19. System for spill free refuelling comprising means for establishing a liquid tight connection between a refuelling gun nozzle for fuel dispensing and a coupling piece of the fuel receiving object, through which fuel is intended to be provided to a fuel container of said object and further comprising means for detecting a predetermined fuel level and for automatically interrupting the fuel flow when said level is detected, **characterized in** that a level detection signalling configuration is arranged to be established by means of moving said gun (1) into position for establishment of the liquid tight connection.

20. System according to claim 19, **characterized in** that means (26, 27) carried and supported by the gun are provided for transferring signals (26') for detecting said predetermined level (8') to the fuel container (7).

21. System according to claims 19 or 20, **characterized in** that receiving means (28, 29) carried and supported by the gun are provided for receiving a signal corresponding to detection of said predetermined level (8') for further processing.

22. System according to claims 19, 20 or 21, **characterized by** optical signals (26') for detecting said predetermined level.

23. System according to claim 22, **characterized by** an optical fibre (26) and lens (27) arrangement on the gun for transferring optical detection signals (26') and an optical fibre (28) and lens (29) arrangement on the gun for receiving optical signals.

24. System according to claim 22 or 23, **characterized by** reflection means (29', 37) arranged in the container (7) for receiving optical signals, preferably in the form of visible light, transferred to the container, the reflection means being arranged to reflect the optical signals when the fuel level has not reached the reflection means and to transmit a considerable part of the optical signals when the fuel has reached the reflection means due to a change in refractory configuration and in that the change in reflected signal is taken as an indication for the fuel to have reached the predetermined level.

25. System according to claim 24, **characterized in** that the reflection means are arranged so that a certain deviation between transferred optical signals (26') and reflected optical signals is provided, so that means for transfer (26, 27) and means for reception (28, 29) may be positioned close together on the gun, a preferred distance (d) between said means being about 6 mm.

26. System according to claims 24 or 25, **characterized by** a prism and lens arrangement (37) for reflection of transferred optical signals (26') preferably having an arc-shaped configuration and having the same or approximately the same reflection properties irrespective of where along said arrangement transferred optical signals are coming in, whereby the gun may be applied and turned within a certain angle interval (38) substantially maintaining the effective reflection properties.

27. System according to claim 24, 25 or 26, **characterized by** at least one cube corner prism (39) comprised by the reflection means.

28. System according to claim 27, **characterized by** at least three cube corner prisms arranged in a, preferably arc-shaped, row comprised by said reflection means.

29. System according to claim 27 or 28, **characterized in** that each cube corner prism is provided with complementary optics (41) in the form of a lens arrangement for obtaining a deviation between transferred optical signals (26') and reflected optical signals (28') and for concentration of the reflected optical signals.

30. System according to claim 29, **characterized in** that said complementary optics comprise two lens parts (42, 43) arranged on a top surface (40) of a cube corner prism, each part being a portion of a lens and said parts abutting each other with their central portions (42', 43') and being arranged so that optical signals coming in against one part is reflected through the other part, the optical axes of the two parts being off-set with respect to each other and the center (39') of the prism.

31. System according to claim 30, **characterized in** that the general configuration of the two lens parts are off-spherical, one being spherical and one being cylindrical or both being off-spherical to a certain extent in order to accumulate lack of tolerances with respect to positioning of the optical signal transfer arrangement.

32. System according to anyone of claims 26-31, **characterized by** a slit (35) on the fuel receiving side of the connection, through which the optical signals (26', 28') are intended to pass, said slit preferably being arc shaped and being fixed in relation to the reflection means and setting said angle interval.

33. System according to anyone of claims 19-32, **characterized by** means (28, 44) for detecting complete and secure connection between the nozzle and the coupling piece by means of the level detection signalling configuration, said configuration being fully established when said connection is completed.

34. System according to anyone of claims 19-33, **characterized by** a mechanical indication and release arrangement of the gun for indication of complete and acceptable connection between the nozzle and the coupling piece, by moving a release knob (9) from a release position to a coupling position and release of the connection being initiated by an operator pushing said knob (9) back to the release position.

35. System according to claim 34, **characterized in** that the release knob (9) is supported by a linkage arm (14) arranged to co-act with a release ring (17) tiltably connected to an outer sleeve (18) of the nozzle, said sleeve being intended to be moved towards the coupling piece in relation to the release ring and an inner nozzle part (20) during the nozzle and coupling piece connection procedure, whereby the release ring is tilted and levelled out against a connection sleeve (21) of said inner nozzle part and whereby the release ring turns the linkage arm and the knob to said coupling position and in that, during release of the nozzle from the coupling piece, the linkage arm, by an operator pressing the knob to said release position, being arranged to tilt the release ring, which due to its attachment to the outer sleeve is arranged to push the connection sleeve towards the nozzle free end and thereby releasing the coupling piece from the nozzle.

36. System according to claim 34 or 35, **characterized by** shutter means (44) of a linkage arm arrangement for said knob, by means of which reflected optical signals are stopped from being communicated to further processing when said knob is in the release position, and in that said communication is opened by moving said shutter means when the knob is moved to said coupling position.

37. System according to anyone of claims 19-36, **characterized in** that the fuel connection between the nozzle and the coupling piece is arranged so that it is opened in successive steps during the coupling procedure, the nozzle being arranged to open the coupling piece and the coupling piece being arranged to open the nozzle thereafter and vice versa when closing, the nozzle being closed before the coupling piece being closed.

38. System according to anyone of claims 19-37, **characterized in** that a fuel pipe (8) is provided, through which fuel is intended to be entered into the fuel container, said pipe acting as a support for the reflection means (29') and ending below said predetermined level (8').

39. System according to anyone of claims 19-38, **characterized by** a two-way optical communication between an object optical communication unit (45) of the fuel

receiving object carried by the object and an optical control and communication central unit (32).

40. System according to claim 39, **characterized in** that said two-way optical communication is arranged by means of light decoding and a communication prism (46) co-acting with a dual optical communication fibre (47) connected to the object optical communication unit (45).

41. Method for detecting a predetermined liquid fuel level comprising detecting the liquid level in a container for the liquid and producing an indication signal when said level is reached, **characterized by** the steps of

- arranging a transparent prism arrangement (37) in the liquid container (7);
- providing an optical detection signal (26') falling in against said prism arrangement;
- reflecting said signal by the prism arrangement and detecting the reflected signal (28');
- contacting the prism arrangement with the liquid when the predetermined level (8') is reached, whereby the refractory configuration is changed so that the signal to a considerable extent is transmitted into the liquid instead of being reflected
- detecting the decrease in reflected light.

42. Method according to claim 41, **characterized in** that said signals (26', 28') are beams of light, preferably visible light.

43. Method according to claim 41 or 42, **characterized by** arranging the prism arrangement so that a certain deviation takes place when the signal is reflected.

44. Method according to claims 41, 42 or 43, **characterized by** arranging the prism arrangement together with a lens arrangement (41) in an extended arrangement to provide reflection and deviation for different positions of the detection signal (26') relative to the prism and lens arrangement.

45. Method according to claim 41, 42, 43 or 44, **characterized by** reflecting said detection signal (26') by at least one cube corner prism (39).

46. Method according to claim 4, **characterized by** arranging at least three cube corner prisms in a row.

47. Method according to claim 45 or 46, **characterized by** deviating and concentrating the light reflected by a cube corner prism (39) by means of complementary optics (41) in the form of two lens parts (42, 43) arranged on a top surface (40) of the prism, the lens parts abutting each other by their central parts (42', 43'), and
5 their optical axes (42'', 43'') being off-set with respect to each other and the center (39') of the prism.

48. Device for detecting a predetermined liquid fuel level, comprising means for detecting the liquid level and for producing an indication when said level is reached,
characterized by

- 10 - reflection means (29') comprising a transparent prism arrangement and intended to be disposed in the container;
- means (26, 27) for providing an optical detection signal (26') intended to enter said prism arrangement;
- means (28, 29) for receiving and detecting reflected detection signals (28');

15 **and in that**

- the reflection means are arranged so that detection signals are reflected, when the liquid has not reached the reflection means, and are transmitted into the liquid when the liquid has reached the reflection means due to the change in refractory configuration.

20 49. Device according to claim 48, **characterized in** that said signals (26', 28') are beams of, preferably visible, light.

50. Device according to claim 48 or 49, **characterized in** that said prism arrangement is arranged so that a certain deviation is obtained between entering signal (26') and reflected signal (28').

25 51. Device according to claims 48, 49 or 50, **characterized by** a prism arrangement with complementary optics (41), comprising a lens arrangement arranged in an extended arrangement to provide reflection and deviation for different positions of the detection signal (26') relative to the prism and lens arrangement.

52. Device according to claim 48, 49, 50 or 51, **characterized in** that said reflection
30 means comprise at least one cube corner prism (39).

53. Device according to claim 52, **characterized in** that said reflection means comprises at least three cube corner prisms arranged in a, preferably arc-shaped, row.

54. Device according to claim 52 or 53, **characterized by** complementary optics for deviation and concentration of signals in the form of two lens parts (42, 43) arranged on a top surface (40) of a cube corner prism (39), the lens parts abutting each other by their thickest central parts (42', 43') and their optical axes (42'', 43'') being off-set with respect to each other and the center (39') of the prism.

55. Device according to claim 54, **characterized in** that the optical axis (42'', 43'') of each lens (42, 43) falls within the respective lens material on the prism.

56. Device according to claim 54 or 55, **characterized in** that the line of cut (39'') between the two lens parts of a prism is directed to the rotation center of the reflection means, these being arranged in an arc-shaped configuration.

57. Device according to anyone of claims 50 – 56, **characterized in** that, due to deviation etc., the reflection means are arranged to produce two spots, one on each side of the signal transfer arrangement (26, 27), one of said spots being intended to fall on the means (28, 29) for receiving reflected detection signals for detection.

58. Fuel pipe arrangement, intended to be arranged in an entry portion of a fuel container and carrying and supporting a coupling piece, arranged to be connected to a fuel dispensing nozzle, **characterized in** that the pipe (8) terminates in the container (7) a certain distance below a predetermined fuel level (8'), above which the container is intended not to be filled with fuel.

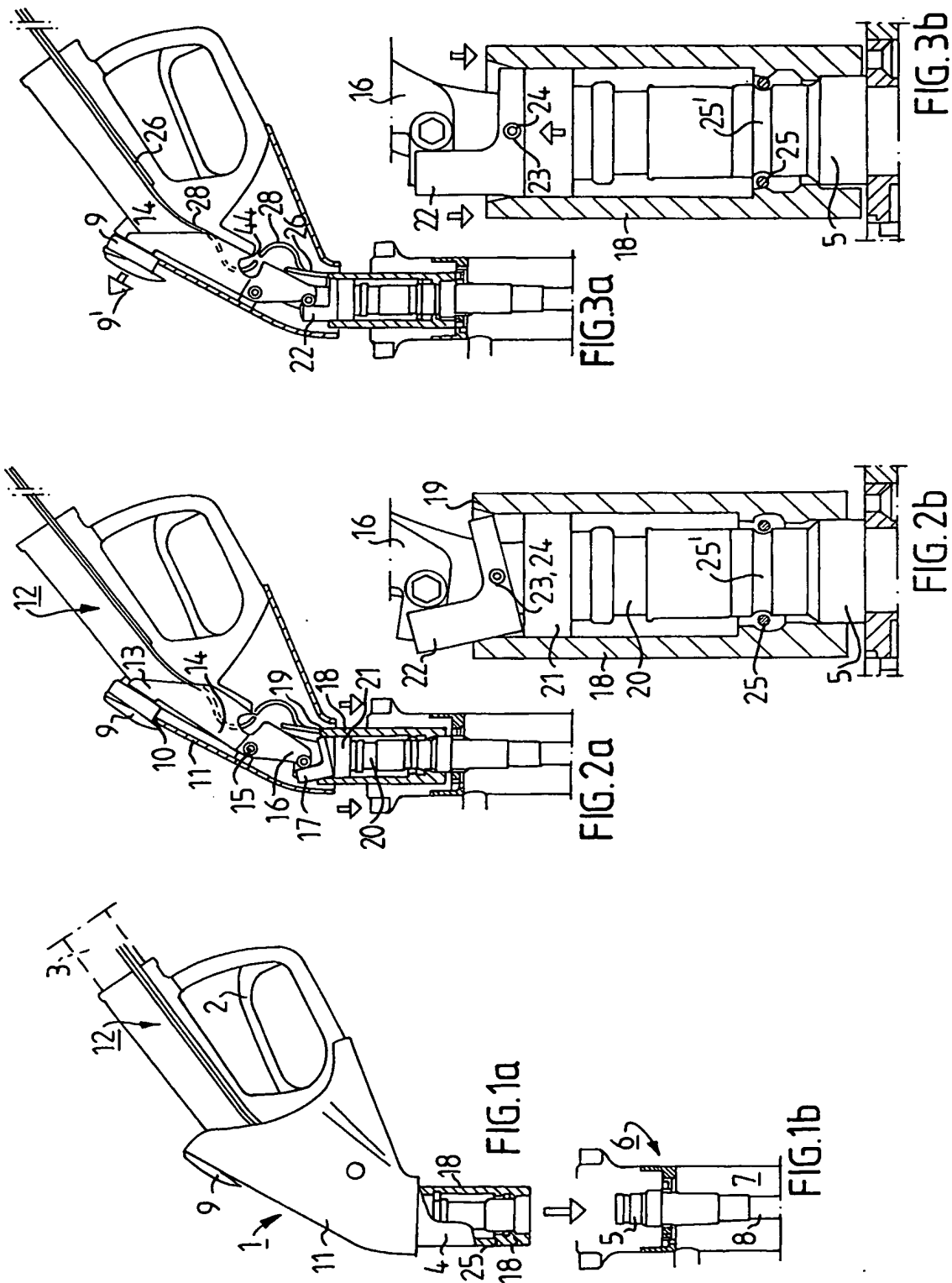
59. Arrangement according to claim 58, **characterized in** that the fuel pipe and the coupling piece (5) are fixed in said entry portion by means of a bracket member (34) comprising a slit (35), through which optical communication between means (29') inside and means (26, 27, 28, 29) outside the container, respectively, is intended to be performed.

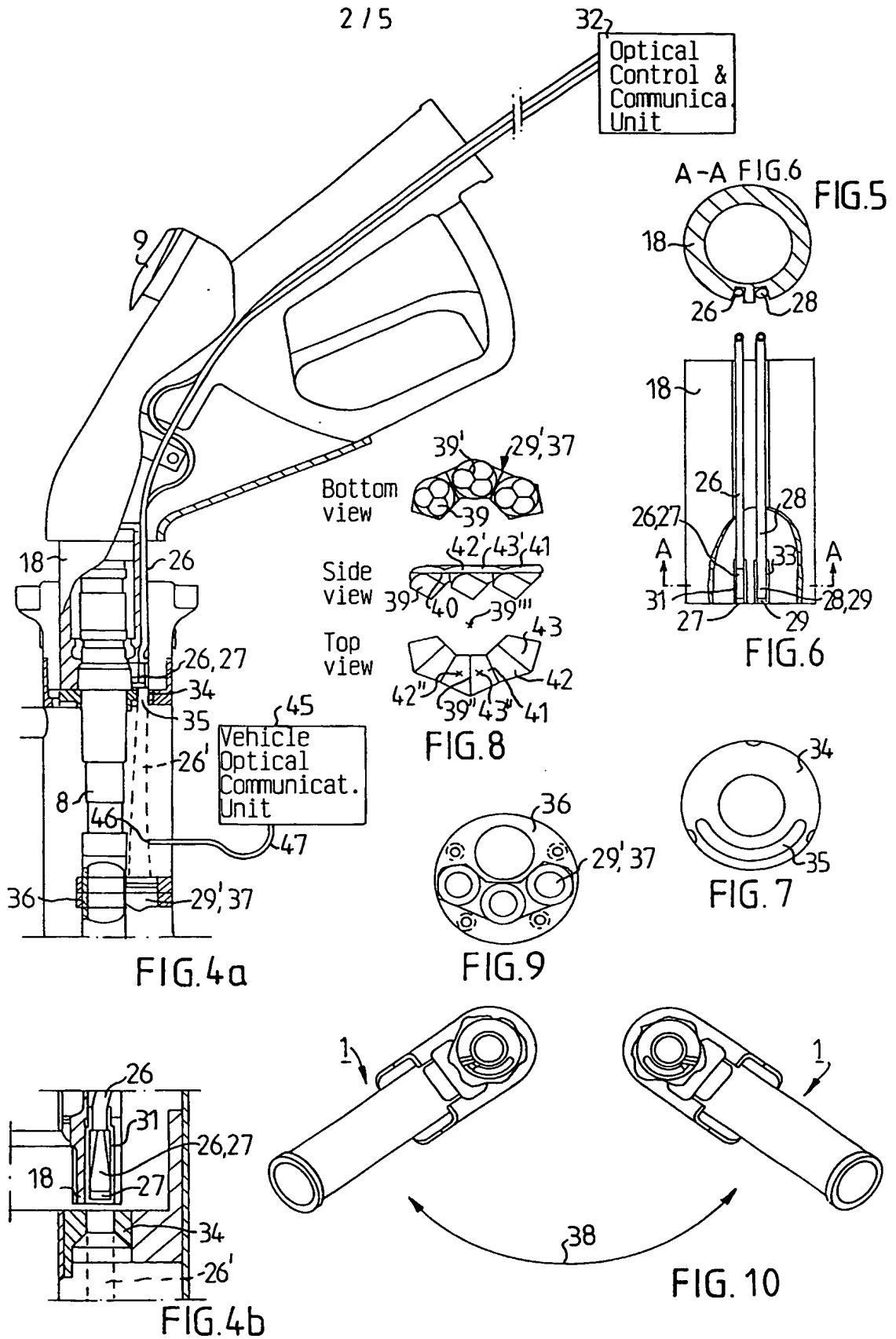
60. Arrangement according to claim 59, **characterized in** that said bracket member, the fuel pipe and the coupling piece together constitute a liquid tight seal of said entry portion.

61. Arrangement according to claim 59 or 60, **characterized in** that a transparent member is arranged in said slit, sealing said slit in a liquid-tight way.

62. Arrangement according to anyone of claims 59 – 61, **characterized in** that the fuel pipe is intended to carry and support optical reflection means (29') for detection
5 of said predetermined fuel level in a position fixable in relation to said slit.

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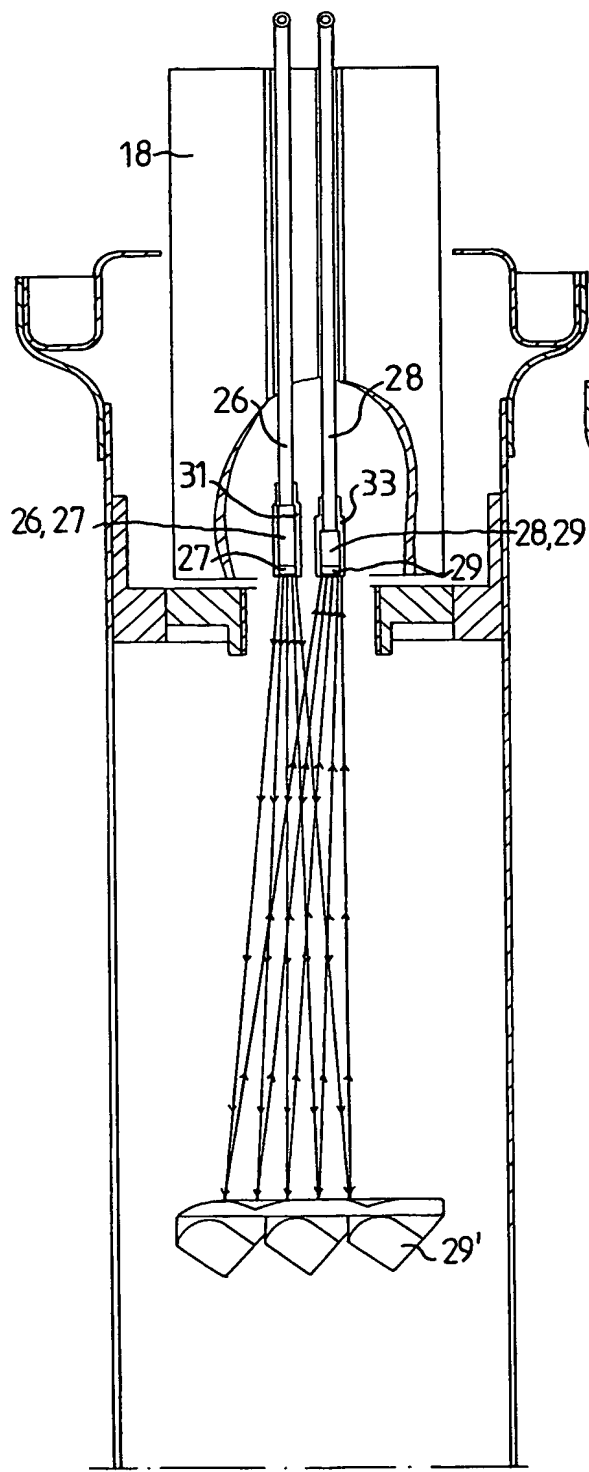


FIG. 11

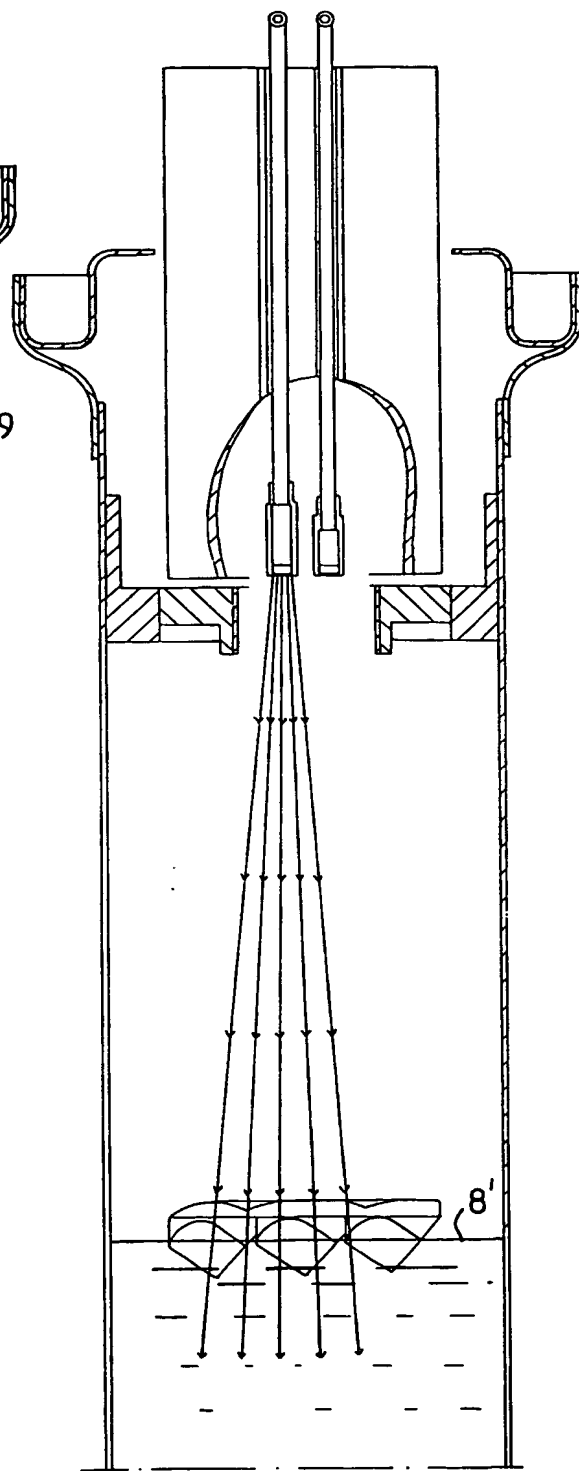
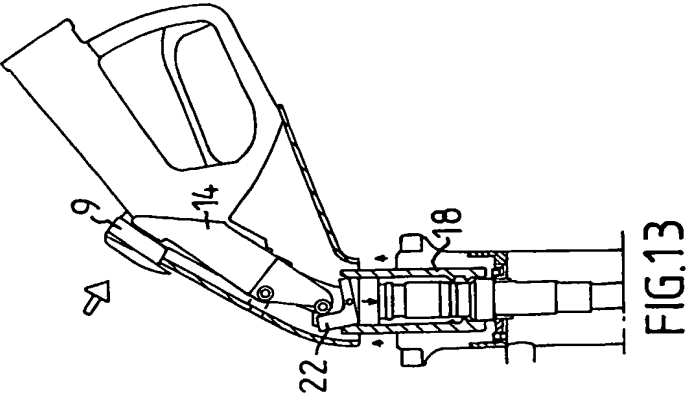
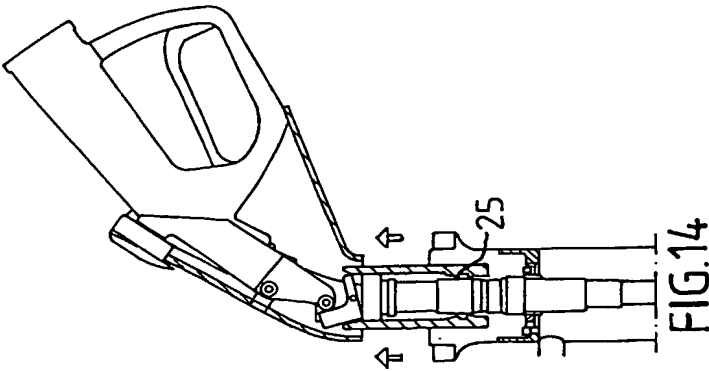
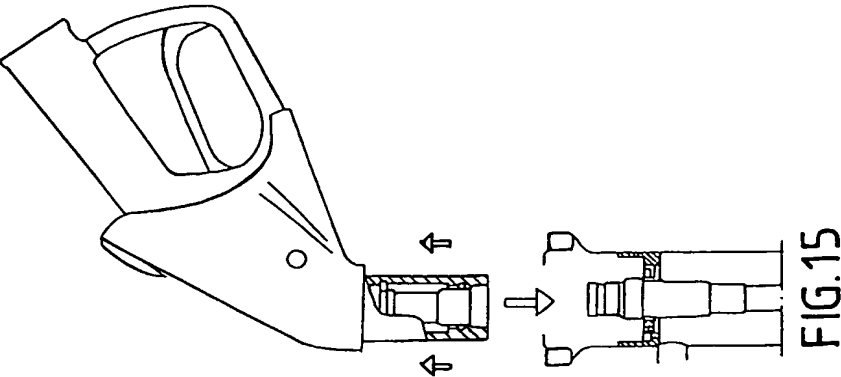
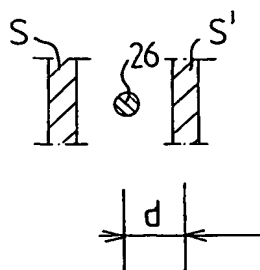
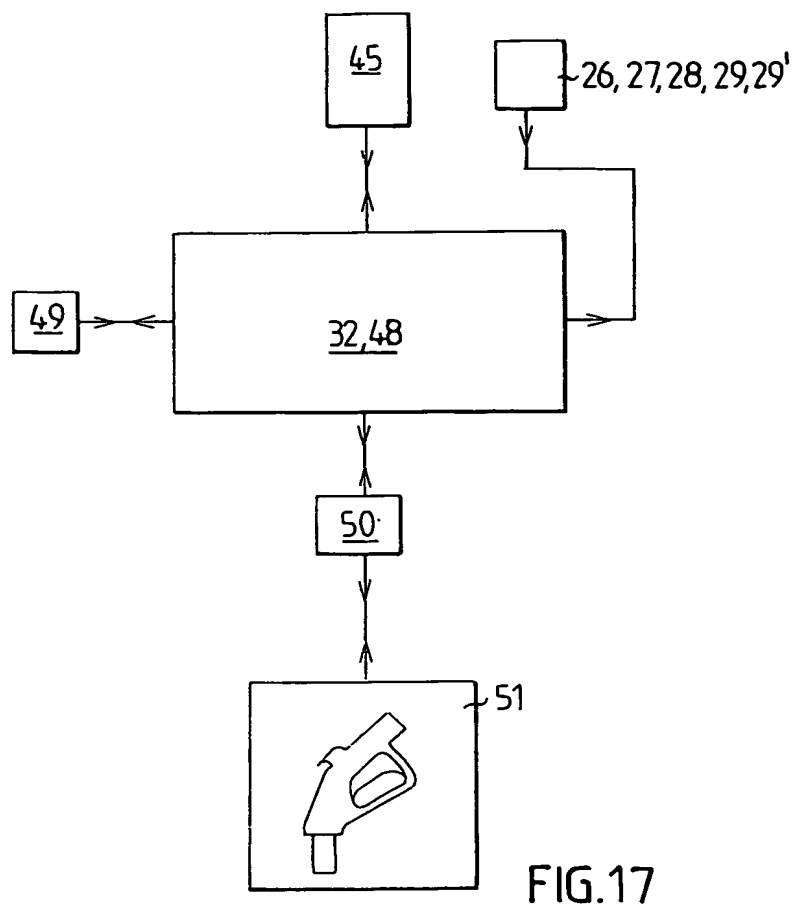


FIG. 12



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/00681

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B67D 5/372, G01F 23/292, B60K 15/077

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B67D, G01F, B60K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3662924 A (STANLEY C. CRANDALL ET AL), 16 May 1972 (16.05.72), column 1, line 30 - line 39, column 5, line 15 - line 34, figure 2 --	1-57
X	US 4053002 A (THOMAS B. LUDLOW), 11 October 1977 (11.10.77), claims 2-3,14, abstract --	1-57
X	US 4503994 A (WALTER R. PYLE), 12 March 1985 (12.03.85), column 3, line 58 - line 68, column 5, line 12 - line 15, abstract --	1,19

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

22 January 2003

Date of mailing of the international search report

23-01-2003

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Mårten Hulthén/MP

Telephone No. +46 8 782 25 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5785100 A (STEVE SHOWALTER ET AL), 28 July 1998 (28.07.98), column 6, line 4 - line 19, figures 3-4 --	41-57
X	EP 0697370 A1 (SCULLY SIGNAL COMPANY), 21 February 1996 (21.02.96), column 1, line 17 - line 18, column 5, line 9 - line 37, figure 1, abstract --	41-57
X	GB 2138947 A (CHILTERN GLASS FIBRES LIMITED), 31 October 1984 (31.10.84), page 3, line 11 - line 18, abstract --	41-57
X	US 3864577 A (JACQUES PIERRE PELLETT ET AL), 4 February 1975 (04.02.75), abstract --	41-57
A	US 4840137 A (THOMAS BEAUVAIS ET AL), 20 June 1989 (20.06.89), abstract, column 6, line 34 - line 39 --	1-57
A	US 5880480 A (SYLVESTER M. ELLINGER ET AL), 9 March 1999 (09.03.99), column 4, line 34 - column 5, line 15, figure 7 --	1-57
A	WO 9719339 A1 (NEDERLANDSE ORGANISATIE VOOR TOEGEPASTNATUURWETENSCHAPPELIJK ONDERZOEK TNO), 29 May 1997 (29.05.97), page 7, line 24 - line 29, claim 12 -- -----	9-11,27-29, 45-47,52-54

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE02/00681

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-57

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE02/00681

This application contains three different inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1 and 13.2.

I. Devices and methods for spill-free refuelling and for detecting a predetermined liquid fuel level according to claims 1-57

II. Fuel pipe arrangement according to claims 58-62.

The invention according to group I (claims 1-57) is intended to solve the problem of obtaining a system of dispensing fuel that interrupts the filling procedure at a certain liquid level and that is safe from a spark/fire point of view. This is achieved by a level detection-signalling configuration disclosed in independent claims 1, 19, 41 and 48.

Group II (claims 58-62) is directed to a fuel pipe arrangement intended to be arranged in an entry portion of a fuel container and carrying and supporting a coupling piece arranged to be connected to a fuel dispensing nozzle.

As both problems and solutions are technically so different, no single general concept can be formulated based on the technical features of the three inventions. In consequence, it is established that the requirements of PCT Rule 13.1 are not met.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/00681

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	3662924	A	16/05/72	NONE		
US	4053002	A	11/10/77	NONE		
US	4503994	A	12/03/85	NONE		
US	5785100	A	28/07/98	NONE		
EP	0697370	A1	21/02/96	CA	2155279 A	06/02/96
				US	5507326 A	16/04/96
GB	2138947	A	31/10/84	GB	8310096 D	00/00/00
				GB	8409696 D	00/00/00
				US	4598742 A	08/07/86
US	3864577	A	04/02/75	BE	807028 A	07/05/74
				DE	2355097 A	16/05/74
				FR	2213487 A,B	02/08/74
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				DE	3918728 A,C	03/01/91
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				DE	69610218 D,T	25/01/01
				EP	0861432 A,B	02/09/98
				SE	0861432 T3	
				JP	2000500581 T	18/01/00
				US	6239875 B	29/05/01